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ABSTRACT

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Running Head: REVIEW OF PROCESS AND COMPUTER-BASED WRITING

Process and Computer-Based Elementary Writing Curriculum: A Review of Methods and Assessments

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Abstract

The purpose of the review of literature was to synthesize a wide range of both quantitative and qualitative studies of teacher implementation of computer-assisted writing curriculum methods. Studies on the effect of computer-assisted learning, the relationship of computers and children's writing, and assessment methods for traditional and electronic writing environments were reviewed. Computer platforms of word processing, interactive multimedia and hypermedia were juxtaposed with inherent problems of assessing these newly popular and proliferating writing curriculum environments. Potential obstacles, possible solutions and new concerns for evaluating student's electronically published writings were addressed to illuminate available directions to the dilemma of teacher assessment of electronically created writings.

Key words: Process writing, computer-based writing, writing assessment.

Introduction

There is a definite connection between educational instructional methods and assessment tools. As instructional methods are developed, tools for assessing these methods are created. This coexistence is present in the relationship between the process method of writing instruction, computer-based writing instruction and writing assessment for elementary students. While a wide array of elementary writing assessment instruments exist for process writing, assessments for newly popular and proliferating computer-based writing instructional methods have yet to be developed. The literature review examined the following areas in elementary education: (a) process writing instruction; (b) writing assessment; (c) computers and learning; (d) computers and writing; and (e) the need for new assessments for alternative writing environments.

Process Writing Instruction: Theory and Practice

According to Langer and Allison (1992) process writing theory emanated in the early 20th Century from the student-centered and experientially driven philosophies of John Dewey. Currently writing theory stems from three additional sources: (a) the socially oriented views of language of the 1960s, represented by the Three Stage Model that shifted writing instruction away from text-based and towards experientially-based philosophies; (b) subsequent research on the process of writing which extend the Three Stage Model in the 1970s and expressed it as the Recursive Model; and (c) the sociolinguists of the 1980s

to present who focused on the language learner in a social and cultural context.

Reed (1996) described two models of writing: the Three Stage Model and the Recursive Model. The Three Stage Model consisted of three discrete stages: (a) pre-writing, the method for generating ideas; (b) drafting, the elaboration of ideas; and (c) revising, the transformation of meaning and mechanics. This model of writing was viewed, as Snyder (1994) related, not solely as a mechanical exercise, but as a process that involved the constructing of meaning. Students constructed meaning as they worked to enhance their abilities to think critically, analyze, classify, compare, and draw conclusions. On the other hand, the Recursive Model of the 1970s, built on the framework of the Three Stage Model, referred to the recursive nature of writing which required the writer to construct meaning by engaging in the non-linear processes of selecting, organizing and connecting information (Palumbo & Prater, 1993).

Beginning in the 1970s and continuing into the 1990s sociolinguists and learning theorists pointed to the connection between language and learning to write, and the gender and culture of the learner. Chomsky (1981) articulated in 1971, referring to the beginning writer, that children should write at the earliest possible age using inventive spelling drawn from culturally familiar words. As a result, "this whole approach introduces him to the written word by making him aware that it belongs to him and grows out of his own consciousness" (p. 142). In addition to the importance of the cultural affiliation of the writer, Jenkins (1993) viewed the gender and race of the writer as a vital component of writer-teacher interaction which authenticated the process of writing and made it intrinsically meaningful. Moreover, Johnson-Eiolola (1995) stated, that the current theory of critical literacy which emphasized the dialogue between teacher and writer produced significant gain as the writer engaged in critical self-evaluation. Thus, writing theorists have developed conceptual models for instruction that advocated purposeful communication as the focus for process-oriented instruction (Langer & Allison, 1992).

According to Strech (1994) the implementation of process-oriented writing instruction in elementary education curriculum occurred through writing workshop. Writing workshop was first articulated by Graves in 1983, and structured the teaching of writing into four categories: (a) brainstorming, (b) drafting, (c) revision, (d) publishing (Strech, 1994). This represented an expansion of the Three Stage Model and functioned to provide the elementary classroom teacher a means to structure writing curriculum (Langer & Allison, 1992).

In Graves (1983) seminal work, Writing: Teachers & Children At Work, the twin crafts of teaching and writing were addressed as Graves illustrated the transformation of the Three Stage Model and Recursive Model into a working. In addition to the three stages identified by Reed, Graves stressed six additional points for elementary teachers of process-oriented curriculum: (a) organize the classroom for writing by conducting group meetings; (b) inundate children with literature; and (c) take the time to write while the children write in order to set the tone for a positive writing atmosphere; (d) conduct conferences with children at various stages of the writing process to empower the learner with skills to revise for meaning and edit for mechanics; (e) keep the mechanics of writing (usage, punctuation, and handwriting) separate from the construction of the content of writing; and (f) observe, assess and record how your students develop as writers, through journaling and creation of record keeping portfolios (collections of student work). These points were derived to clarify the enacting of process-oriented writing curriculum (Graves, 1983).

While Graves (1983) globally discussed the transformation of an entire classroom into a writing workshop, Calkins (1983) provided the practitioner, in Lessons From A Child, with the perspective of the individual child's experience as a developing writer in a writing workshop environment. Two main points were illuminated by Calkins: (a) after a period of time in a writing workshop, the student internalizes methods such as revision, or any processes inherent in the other writing stages; and (b) conferencing, or the method of

communication between teacher and child during writing workshop, can occur at any writing workshop stage, and more importantly, can be effectively accomplished via peer-conferencing. Thus, Calkins extended the concept of writing workshop to include a student-centered approach via peer-conferencing, as opposed to a solely teacher-directed one, for the organization and practice of writing in the classroom (Strech, 1994).

As writing workshop proliferated and became increasingly popular as a method of teaching elementary writing instruction, new problems arose that the material of Graves (1983) and Calkins (1983) had not fully explored. The open-ended and student-centered qualities of writing workshop led to teacher struggles with the instruction of writing workshop. Neither Graves nor Calkins revealed explicit instructional procedures from which to approach writing workshop (Strech, 1994). Calkins (1986) and Atwell (1987) addressed this weakness by providing the writing workshop instructional dialogue practice by providing teachers with an organizational strategy referred to as mini-lessons.

The mini-lesson (Calkins, 1986; Atwell, 1987) functioned to enhance the instruction of any stage of writing workshop in three ways. First, as the teacher observed students at work, basic and sophisticated problems experienced by students were recorded for resolution through brief discussion. For example, if writing materials were not cared for properly (classroom management) or story themes were not being fully developed (conceptual learning) the mini-lesson would be applied to solve the problem. Second, the mini-lesson was used to incorporate experiences depicted in literature of various genres, in order to teach literacy concepts covered in professionally written materials. Third, mini-lessons facilitated the process of sharing student work in order to instill pride and ownership in student-authors as well as enabling students to learned from each other.

Support for the effectiveness of the mini-lesson approach was revealed by Sinicki (1996) in a study consisting of several school districts. The purpose of the study was to contrast the use of mini-lessons versus traditional methods of writing instruction. The implementation of mini-lessons into the writing curriculum of 180 elementary students

(grade 3) indicated that students whose teachers incorporated more mini-lessons into their writing instruction scored higher on the Illinois Goals Assessment Instrument than students' whose teachers incorporated the use of trade-books for writing instruction.

Calkins and Harwayne (1991), in an effort to enhance teacher practice in the brainstorming stage of writing workshop, found that effective use of journal writing by children (writing without teacher prompts), served to organize freely flowing ideas that might otherwise be lost. The open-ended nature of journal writing, and the fact that children were encouraged to draw their ideas as well as write them, made the exercise conducive to the creation of running records of children's ideas that, at a later time, could be developed into publishable products.

Calkins and Harwayne's recognition of journaling and other methods of allowing students to demonstrate growth in writing through non-traditional writing dictated that an alternative means of assessment be created (Graves & Sunstein, 1992). Thus, it is necessary to examine writing assessment before reviewing the integration of computers and process writing in order to accurately recommend new research for the assessment of computer-based process writing.

Writing Assessment Research and Practice: 1960's to Present

There exists a commonly expressed desire, from a wide range of professionals in education, to use writing assessment as a guide to instructional practice (Graves, 1983; Gearhart, Herman, Baker & Whittaker, 1992; Zelhart & Plata, 1991; Wolf, 1994; Gearhart, Herman, Novak & Wolf, 1995; Townsend, Danling & Leonard, 1997). Huot (1990) revealed, in his oft cited and comprehensive review of writing assessment research, that this commonly expressed desire, for writing assessment to serve as a guide to teacher writing curriculum, has not been fulfilled. Instead writing assessment has tended to develop as a reaction to, rather than simultaneously with, curriculum transformations derived from the practitioners of writing instruction (Huot, 1990).

Generally, Huot (1990) divided writing assessment research into two categories

representing two distinct time periods: indirect (pre-1970) and direct assessment (mid-1970s to present). Indirect writing assessment was described as the process of assessing parts or components of texts, as opposed to an entire text. Indirect measures included isolated scoring of writing such as mechanics and usage not viewed in the context of the whole essay. Whereas, direct assessment was defined as the assessment of an entire piece of writing. The transformation of writing assessment from indirect to direct measurement occurred, according to Elliot (1991), as a result of the belief that the goal of objectivity was not as important as controlled subjectivity.

Despite noted differences in indirect and direct measurement, it is important to note Spencer and Fitzgerald's (1993) observation that "virtually all direct writing measurement involves both readers and texts, and that, except in cases of machine scoring of indirect measures, the two anchoring points (reader- vs. text-based) cannot be totally separated" (p. 213). Nonetheless, Zelhart and Plata (1991) found one distinction between indirect and direct writing assessment in that indirect measures of writing, unlike direct measures do not distribute minority students similarly to non-minority students.

Huot's Review of Writing Assessment Research[1]

Huot identified three types of direct assessment: (a) primary trait assessment in which rhetorical demand (the intended audience for the writing assignment) created the scoring criteria; (b) analytic trait assessment whereby writing was assessed by identifying set qualities of writing that were perceived as representing good writing, and scored by tallying the number of qualities evident; and (c) holistic assessment which represented raters' general impression of the quality of the writing sample with scales or rubrics providing guidelines for scoring.

Research on, the first type of direct assessment, primary trait assessment revealed

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[1] This entire section is based on Huot (1990).

three possible influences on how judges scored writing samples. The first was discourse mode (the type of writing requested in a writing assignment, such as reflective or argumentative). Discourse mode effected writing quality for the simple reason that different writing tasks varied in degrees of difficulty. Each writing assignment was considered a unique entity. For example reflective writing assignments were easier than analytic assignments.

Another theoretical influence on rater judgment was rhetorical specification, which was defined as the relationship between the specified audience and the quality of writing. Writing resembled spoken discourse when the writer viewed the audience as familiar or close and writing tended to be revised more when the specified audience was an unfamiliar one, however no effect on scoring of essays was found. The third possible influence on primary trait scoring was identified as writing prompt structure, which revealed that the nature of the writing prompt can be designed into high and low demand prompts. Despite the existence of high and low demand prompts, no significant differences were found for scoring judgments based on the different levels of prompts.

Analytic trait, the second type of direct assessment identified by Huot, was influenced by three textual features of writing quality. For both analytic trait and holistic assessment the construct of quality was further classified by the content, organization and overall merit of a text (Spencer & Fitzgerald, 1993). First, writing cohesion, which measured the degree to which an essay was organized replaced the writing assessment measure of T-unit length (complexity of the clauses found in a writing sample). High quality writing tended to have a greater level of cohesiveness, as measured by amount of cohesive ties, than did lower quality writing. Cohesive ties consisted of the semantic relations inherent to the writing that make it a text. Also, research on elementary aged writers revealed a relationship between syntactic maturity, measured via intersentential analysis using T-unit length and number of clauses per T-unit, and writing quality. But, the relationship between syntactic maturity and writing quality was not evident for older

non-elementary writers. Moreover, raters of analytic trait assessments were more influenced by vocabulary diversity than syntactic maturity.

Holistic assessment represented the third form of direct assessment in Huot's review and depicted raters' general impression of the quality of a writing sample. While analytic trait assessment required set qualities of good writing, holistic assessment depended upon guidelines that provided characteristics of good writing. Holistic assessment also revealed its influence on rater judgment of writing quality through: environmental variables, in which raters' scoring was effected by the rating session-ratings by those trained by raters during the scoring session are influenced by the assessment trainers; writing style, whereby nominal (complex) writing received higher scores than verbal (simple) writing; and personal experience, in which scoring reflected the personal experience of the rater as opposed to solely reflecting the qualities inherent to the text.

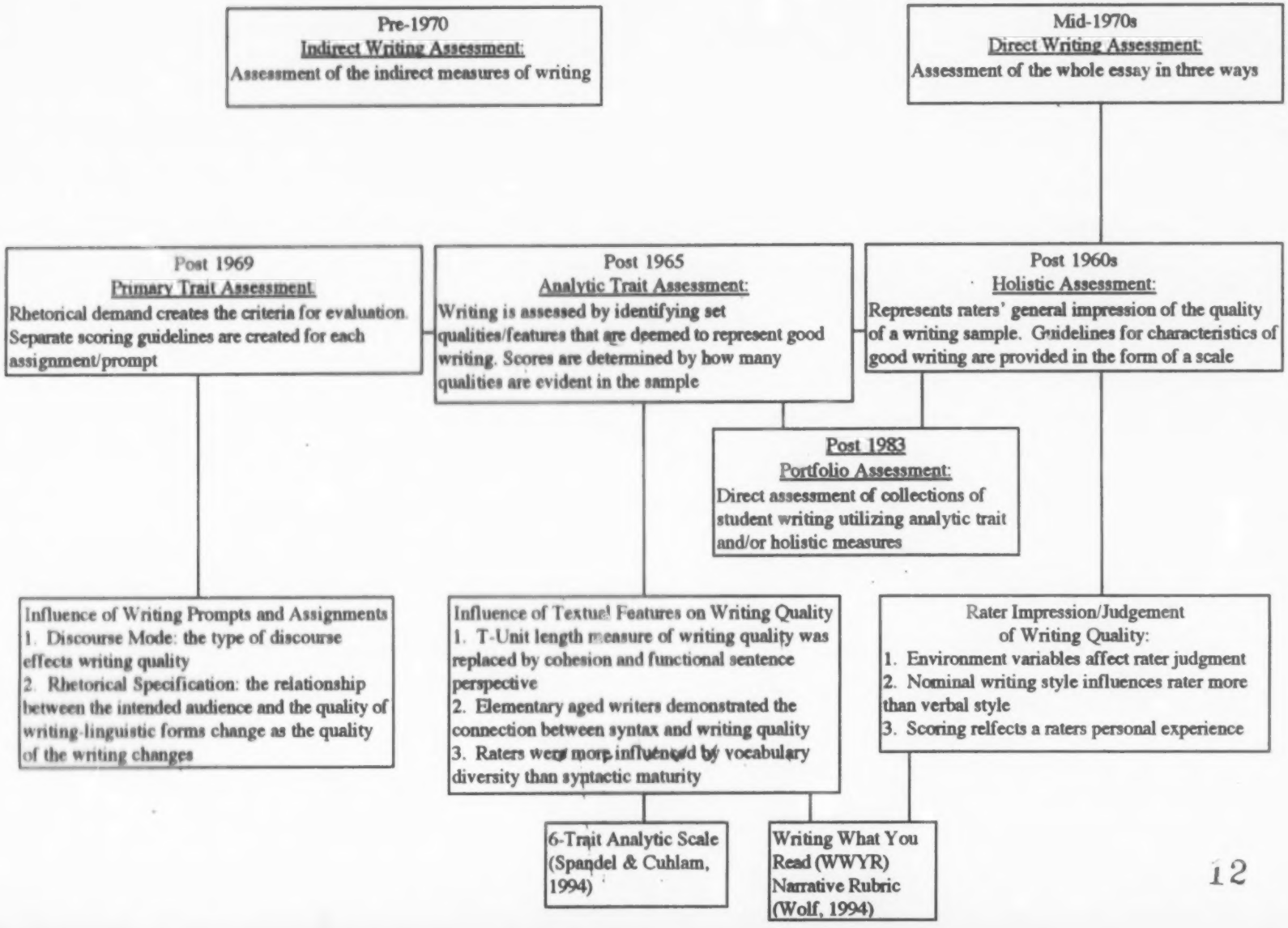
New Definitions of Writing Assessments

Spandel and Stiggins (1997) recently reviewed, categorized and defined primary trait, analytic trait and holistic assessment, finding that primary trait scoring was utilized to assess one primary trait of an essay such as organization and was therefore scored based solely on that trait, and analytic trait assessments had most often utilized the traits of ideas, organization, voice, word choice, sentence fluency, and conventions considered critical to good writing. Furthermore, holistic assessment was re-defined as focused holistic scoring, in which scoring is based upon explicit criteria set forth by the determined measure of assessment and general impression holistic scoring, in which raters assessed papers by comparing them to a set list of exemplars. (See Figure 1. for a summary of writing assessment).

Direct and Portfolio Assessment

Direct assessments, such as analytic-trait and holistic assessments have recently been incorporated into and sometimes consumed by portfolio assessment, which by definition can take the form of any direct assessment under the umbrella term "portfolio

Figure 1. Writing Assessment Research: Definitions, Time Table and Sample Instruments


Pre-1970
Indirect Writing Assessment:
Assessment of the indirect measures of writing
Mid-1970s
Direct Writing Assessment:
Assessment of the whole essay in three ways
Post 1969
Primary Trait Assessment:
Rhetorical demand creates the criteria for evaluation. Separate scoring guidelines are created for each assignment/prompt
Post 1965
Analytic Trait Assessment:
Writing is assessed by identifying set qualities/features that are deemed to represent good writing. Scores are determined by how many qualities are evident in the sample
Post 1960s
Holistic Assessment:
Represents raters' general impression of the quality of a writing sample. Guidelines for characteristics of good writing are provided in the form of a scale
Post 1983
Portfolio Assessment:
Direct assessment of collections of student writing utilizing analytic trait and/or holistic measures
Influence of Writing Prompts and Assignments
1. Discourse Mode: the type of discourse effects writing quality
2. Rhetorical Specification: the relationship between the intended audience and the quality of writing-linguistic forms change as the quality of the writing changes
Influence of Textual Features on Writing Quality
1. T-Unit length measure of writing quality was replaced by cohesion and functional sentence perspective
2. Elementary aged writers demonstrated the connection between syntax and writing quality
3. Raters were more influenced by vocabulary diversity than syntactic maturity
Rater Impression/Judgement of Writing Quality:
1. Environment variables affect rater judgment
2. Nominal writing style influences rater more than verbal style
3. Scoring relfects a raters personal experience
6-Trait Analytic Scale (Spandel & Cuhlam, 1994)
Writing What You Read (WWYR) Narrative Rubric (Wolf, 1994)

system" (Callahan, 1995, p. 117) applied to collections (as opposed to individuals samples) of student writing samples. McMillan (1997) recently defined portfolios as "a purposeful, systematic process of collecting and evaluating student products in order to document progress toward the attainment of learning targets" (p. 231). Portfolio assessments have long been considered as an alternative to standardized testing, enabling students to master material (Gilman & Hassett, 1995; Brown, 1997). Mirroring the sentiments of teachers of process writing, White (as cited in Huot, 1994) contended that assessment imposed from outside the classroom can be a threat to learning. Support for portfolio assessment, as well as criticism of standardized testing has led to a clarification of possible uses for portfolio assessment.

Callahan (1995) identified three types of applications for portfolio assessment: (a) instructional, (b) formal testing, and (c) program development. First, portfolio assessment has been considered more accurate and consistent with classroom practice and, since instruction and assessment are interwoven, has been used as a tool to teach self-assessment to students. Second, for formal classroom testing portfolios have been considered more accurate than assessments which rely on one writing test. However, for institutional testing, serious reliability and validity issues have arisen. Third, portfolios have been utilized for program development due to the symbiotic relationship of instruction and assessment in process writing instruction.

Increasingly since Graves (1983) and Graves and Sunstein (1992) called for more authentic assessment, portfolio assessments have made use of a wide array of assessment instruments. However, primary trait assessments have not been utilized in direct writing assessment due to their high expense and length of time to administer (Huot, 1990). Therefore, research on the reliability and validity of direct assessments has primarily occurred in examinations of analytic-trait and holistic rubrics applied as formal tests (Huot, 1990; Gearhart, Herman, Novak & Wolf, 1995). Analytic trait assessment in the form of a six-point scale (e.g. the 6-Trait Analytical by Spandel & Culham, 1995) and

analytic/holistic assessment combined, along with Writing What You Read (Wolf & Gearhart, 1993; Wolf, 1994), have been evaluated for the following four qualities: (a) reliability of rater scores; (b) validity, including face, construct and developmental; (c) assessment value for classroom instruction; and (d) assessment utility, in which the ability of a rubric is examined for its merit in meeting large-scale assessment requirements.

Reliability of Writing Assessment Scores

Reliability was defined as whether, or to what degree, a test (or writing assessment) applied repeatedly to the same subject or writing sample, will consistently yield the same result (Babbie, 1995). Huot (1990) first pointed out that reliability for ratings from both analytic trait and holistic measures of writing samples have been viewed as acceptable, for classroom assessment as well as large-scale assessment, when weighed against the costly and time consuming characteristics of primary trait scoring. More recently, a study by Herron (1994) involving 40 teachers trained in holistic scoring revealed high levels of inter-rater reliability for holistic assessment (Texas Assessment of Academic Skills) of fourth grade-created narratives. The combination of adequate reliability, as measured by percent of rater agreement of resulting correlational coefficients, for analytic trait and holistic assessments, and benefits in cost and time have led a number of educational districts to adopt the measures. Yet, as Spencer and Fitzgerald (1993) related, the problem of validity for analytic trait and holistic measures remains questionable.

Validity of Writing Assessment Scores

Validity, in traditional test theory, has been defined as the appropriateness, meaningfulness, and usefulness of specific inferences made from test scores (Gall, Borg & Gall, 1996). For analytic trait and holistic assessment validity refers to inferences made from raters' scores as opposed to standardized test scores. Researchers examined ratings scores from two rubrics (e.g. the earlier model study by Spencer & Fitzgerald, 1993) in order to support validity for a writing assessment. More recently, researchers compared rubrics, evaluated and non-evaluated, to determine the reliability and validity of the

unproven rubric (Gearhart, Herman, Novak & Wolf, 1995; Novak, Herman & Gearhart, 1996).

In the Gearhart et. al (1995) and Novak et. al (1996) analytic trait and analytic trait/holistic assessment studies, several sources of validity were defined, examined and supported in varying degrees. Both studies utilized ratings of elementary (grades 1-6) narrative writing samples in an effort to compare the more established analytic trait rubric with the less established analytic trait/holistic WWYR rubric, however the Novak study examined collections of narrative writing samples, whereas the Gearhart study examined individual narrative writing samples. Rubric scales for both assessments were identified. The WWYR consisted of five narrative subscales: (a) theme, (b) character, (c) setting, (d) plot and (e) communication, while the analytic trait "comparison" rubric consisted of four scales: (a) general competence, (b) focus/organization, (c) development and (d) mechanics. (For further discussion on the conceptual rationale for both rubrics see: (Wolf, 1994, for the WWYR rubric and Gearhart, Herman, Novak & Wolf, 1995 for the analytic trait rubric). (See figure 2-Writing What You Read Narrative Analytic Assessment Rubric).

In the Gearhart and Novak studies, several validity types were adequately supported for all of the utilized rubrics except for the WWYR setting and plot subscales. Face validity, the degree to which an assessment appears to assess what it purports to assess, was supported by an account of the underlying theoretical frameworks from which the rubrics were designed. Construct validity, the degree to which scores on a writing assessment can produce insight into the meaning of scores in relation to the construct being measured, was approached by examining the degree to which rating scores reflected the chronological age of the author known as developmental validity. In the Gearhart and Novak studies researchers assumed that if the rubrics' ratings accurately reflected higher scores for older children's writings then the assumption that older children are able to write with more skill than younger children would be supported. Ratings for both rubrics successfully reflected this age-skill assumption.

Figure 2. Writing What You Read Narrative Analytic Assessment Rubric (Wolf & Gearhart, 1993a)

Theme	Character	Setting	Plot	Communication
Explicit-Implicit	**Flat-Round**	**Backdrop-Essential**	**Simple-Complex**	**Context-bound-Reader-considerate**
Didactic-Revealing	**Static-Dynamic**	**Simple-Multi-functional**	**Static-Conflict**	**Literal-Symbolic**
1: Not present or not developed through other narrative elements	1: One or two flat, static characters with little relationship between characters	1: Backdrop setting with little or no indication of time or place ("There was a little girl. She liked candy.")	1: One or two events with little or no conflict ("Once there was a cat. The cat liked milk.")	1: Writing bound to context (You have to be there) and often dependent on drawing and talk to clarify the meaning
2: Meaning-centered in a series of list like statements ("I like my mom. And I like my dad. And I like my....")	2: Some rounding, usually in physical description; relationship between characters is action driven	2. Skeletal indication of time and place often held in past time ("once there was...") little relationship to other narrative elements	2: Beginning sequence of events, but occasional out-of-sync occurences; events without problem; problem without resolution	2: Beginning awareness of reader considerations; straightforward style and tone focused on getting the information out; first attempts at dialogue begin
3: Beginning statement of theme-often explicit and didactic ("The mean witch chased the children and she shouldn't have done that")	3: Continued rounding in physical description, particularly stereotypical features ("wart on the end of her nose"); beginning rounding in feeling ("She was sad")	3: Beginning relationship between setting and other narrative elements (futuristic setting to accomodate aliens and spaceships; beginning symbolic functions-forest as a scary place	3: Single, linear episode with clear beginning, middle and end; the episode contains four critical elements of problem, emotional response, action and outcome	3: Writer begins to make sense of explanations and transitions ("because" and "so"); literal style centers on description ("sunny day"); tone explicit
4: Beginning revelation of theme on both explicit and implicit levels through the more subtle things characters say and do ("He put his arm around the dog and held him close. Your're my best pal, he whispered.")	4: Beginning insights into the motivation and intention that drives the feeling and the action of main characters often through limited omniscient point of view; beginning dynamic features (of change and growth)	4: Setting becomes more essential to the development of the story in explicit ways: characters may remark on the setting or the time and place may be integral to the plot	4: Plot increases in complexity with more than one episode; each episode contains problem, emotional response, action, outcome, beginning relationship between episodes.	4. Increased information and explanation for the reader (linking ideas as well as episodes); words more carefully selected to suit the narratives prupose (particularly through increased use of detail in imagery)
5: Beginning use of secondary themes, often tied to overarching theme, but sometimes tangential; main theme increasingly revealed through discovery rather than delivery, though explicit thematic statements still predominate	5: Further rounding (in feeling and motivation); dynamic features appear in central characters and in the relationships between characters; move to omniscient point of view (getting into the minds of characters)	5: Setting may serve more than one function and the relationship between functions is more implicit and symbolic-for example, setting may be linked symbolically to character mood ("She hid in the grass, clutching the sharp, dry spikes, waiting.")	5: Stronger relationships between episodes (with the resolution in one leading to a problem in the next); beginning manipulation of the sequence through foreshadowing, and subplots	5: Some experimentation wtih symbolism (particularly figurative language) which shows reader considerations on both explicit and implicit levels; style shows increasing variety (aliteration, word play, rhythm, etc.) and tone is more implicit
6: Overarching theme multilayered and complex; secondary themes integrally related to primary theme or themes; both explicit and implicit revelations of theme work in harmony	6: Round, dynamic major characters through rich description of affect, intention, and motivation; growth occurs as a result of complex interactions between characters	6: Setting fuliy integrated with the characters, action, and theme of the story; role of setting is multifunctional-setting mood, revealing character and conflict, serviing as metaphor	6: Overarching problem and resolution supported by multiple, episodes; rich variety of techniques (buidling suspences, foreshadowing flashbacks) to manipulate sequence	6: Careful crafting of choices of story structure as well as vocabulary denonstrate considerate orchestration of all the available resources

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Value of a Writing Assessment

The Gearhart and Novak studies on the reliability and validity of analytic trait and analytic/holistic assessment measures addressed the underlying issues regarding the value of the assessment investigated. Two issues were identified as being critical to the value of an assessment: (a) student learning and (b) teacher practice. Wolf and Gearhart (1993a) and Wolf (1994) pointed out that the value of a writing assessment, as a classroom tool for increasing the level of student performance, is the degree to which it informs instructional practice and links teacher comments to students to instructional purposes.

Spandel and Stiggins (1997) found that elementary students must be taught self-assessment in order for their successful growth as writers. The case for student learning of self assessment, was also reported by Rosow (1996) in a study utilizing a sample of 38 second grade students, who revealed that teachers who trained their second grade children to assess their writing, with an analytic trait assessment instrument, enabled those children to improve the quality of their writing in two ways: (a) awareness of good writing from the understanding of the analytic rating scales and (b) ability to engage in self-evaluation. In addition Swan and Meskill (1996) found that writing assessment applications can increase student learning as well as guide teachers in the teaching of writing.

A writing assessment measure must support current literacy frameworks (e.g. the WWYR narrative rubric reviewed earlier) of response-based literature in which non-objective models of critically responding to literature are supported through multiple perspectives to engender meaning making in students (Wolf, 1994). Moreover, despite the evidence for instructional value of analytic trait and holistic assessment the question remains whether such measures retain the utility or ability to reliably and validly assess writing on a large scale.

Utility of a Writing Assessment

The utility of a writing assessment was defined by Gearhart and her colleagues (1995) as the ability of a rubric to meet the technical requirements of large-scale

assessment. According to Spandel and Stiggins (1996) large-scale writing measurements assisted in raising teacher awareness of the larger community's criteria for model writing. Thus, assessments that informed students and teachers and guided teacher practice should also function as school- and district-wide measures. Novak (1996) and Gearhart concluded, in their validity studies, for both the analytic trait and analytic trait/holistic rubrics, that adequate support was established for the reliability and validity of rubric scores for student writing samples. However, Gearhart and Novak stressed that more evidence is necessary to adequately address the technical merit of the rubrics for large-scale use.

There is a critical need for professionals in the fields of process writing and writing assessment to address current changes in literacy education, especially since the writing assessment research literature has exclusively addressed writing with paper and pens (Takyoshi, 1995). According to Campbell (1996) technology should be integral to any reconsideration of literacy education and should permeate teaching as it does in our everyday lives, particularly the life of the young. However, in order to thoroughly understand the computer-based writing research, it is first necessary to examine research on computer-assisted instruction and hypermedia learning.

Learning With Computers

Computer-Assisted Instruction

Computer-assisted instruction (CAI) has been defined as "the use of computer technology in conjunction with classroom instruction" (Wang & Sleeman, 1993, p. 333). Two aspects of CAI will be addressed: (a) a review of research on the effectiveness of CAI and (b) learner control in CAI program environments. CAI research was addressed before examining computer-assisted writing instruction because computers have been used in educational environments for many years.

In research and reviews of CAI in the form of meta-analysis, dating back to 1963 Wang and Sleeman, pointed out the dependent effect of CAI on a number of variables. The

most important variables were: (a) length of study; (b) method of instruction, drill-practice or problem solving; (c) the types of testing procedures implemented; and (d) the controls used. Four components of CAI effectiveness were revealed: (a) student achievement, in which drill and practice CAI had positive results whereas problem solving instruction had only mixed results; (b) learning time, where numerous studies found that CAI reduced the length required to learn in a variety of instructional areas; (c) attitude, where students have continually demonstrated positive attitudes toward using computers; and (d) low-ability students, where the majority of CAI research indicates that use of CAI benefits lower-achieving students more than it does high-achieving students. Wang and Sleeman concluded that their meta-analysis demonstrated only mixed results for the benefits of CAI.

An important aspect of CAI is learner control (Crooks, Steven, Klein, James, Elizabeth & Dwyer, 1996). Learner control was defined by Crooks and his colleagues as the control of options within computer applications. In the Crooks study, learner control theory in CAI was analyzed from two modes: lean-plus (lean-plus is an instructional programs where the learner has the option of requesting an assortment of features), and full-minus. Whereas full-minus instructional programs provide a full assortment of features that learners can elect to bypass. The purpose of the study was to determine the effect of full-minus and lean-plus on the achievement of student participants. Results indicated that those participants receiving full-minus instruction performed slightly better than those who received lean-plus instructional programs.

The majority of research on CAI has examined skill and practice learning environments rather than higher level cognitive problem solving environments. Nonetheless, a shift occurred with the introduction of hypermedia and multimedia computer applications to educational instruction. According to Ayersman (1996), the advent of hypermedia as a learning tool is recent, with HyperCard, an educational hypermedia application program, first introduced in 1987. Hypermedia has been defined by Tergan (1997 as:

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> Subject matter is fragmented in single, autonomous information units, which can be read and interpreted independently. They are represented in the database by means of nodes and links. Nodes in hypertext systems will only contain verbal information, sometimes enriched with graphics, charts, and pictures. Links are electronic connections between nodes, rendering information elements of the hypertext base accessible to the learner. In hypermedia systems, nodes in addition may contain sound, animation, simulation, and video (p. 6).

Thus, hypermedia computer environments subsume multimedia environments.

Multimedia computer applications have been defined as computer environments that facilitate the incorporation of text, audio, video and graphics elements (Palumbo & Prater, 1993). Multimedia presentation capabilities inherent to hypermedia applications enable teachers and learners to present information in attractive formats. The characteristics of hypermedia and multimedia elements have been considered by a wide array of educational professionals to be valuable for instructional purposes. The significant value of multimedia, for young learners was identified by Daiute (1994):

> The computer provides tools for manipulating images and sounds in much the same way as word processor manipulate text. Children can cut, paste, crop, and draw over images stored in the computer, thus being able to interact with the images and reconstruct them as well as examine them (p. 227).

It is important to note that the term CAI that has been used in this section to label instruction with computers although CAI is now considered as a dated term. The term CAI is contextually bound to references of a computer as a replacement for the teacher, or as a means of delivering instruction. In replacement of CAI, several terms were used that usually identify the software environment, i.e. "hypermedia learning" (Tergan, 1997).

Hypermedia Learning

Several educational benefits of hypermedia, including multimedia, have been identified as enhancements to learning: (a) the support of constuctivist learning theory; (b) positive learner attitudes when working with hypermedia; (c) support for multiple learning styles; (d) support for cooperative learning; (e) the suitability for information synthesis; and (h) support for intertextuality.

Researchers have opined that the qualities of hypermedia learning environments are conducive to the enhancement of learning based on constructivist theory (Ayersman, 1996). Constructivist learning theory states that learning occurs through the learners' construction or building of knowledge, and that individual learners utilize a wide array of learning styles to construct knowledge (Gardner, 1991). The connection between hypermedia learning environments and constructivist theory was evident, according to Tergan (1997), in the processing of multiple external representations of a particular subject matter area. Multiple external representations, (for example: text, audio, video, and graphics), facilitate the construction of mental representations, which in turn are considered to be critical for the processing of different higher level cognitive tasks.

Tergan stated that "learning performance and knowledge transfer can be enhanced when subject matter is present using different perspectives, multiple contexts, and multiple codes" (p. 5). The statement defined the relationship between hypermedia and constructivism. Several components that support constructivism in hypermedia learning derived from cognitive theoretical frameworks were identified as: (a) memory encoding, the facilitation of learning through the expansion of representations of information; (b) context-indexed mental representations, in which learning concepts are supported by multiple indexing of meaning associated with the concept; (c) cognitive flexibility, the facilitation of knowledge acquisition through revisiting of similar material in rearranged contexts from different conceptual perspectives; (d) multimodal cognitive processing, the simultaneous processing of visual and verbal information enhanced through graphics, sound, video and

animation; and (e) individualized and self-regulated learning, the self-paced selection and retrieval of information.

Hypermedia learning environments were demonstrated as fostering positive attitudes, supporting multiple learning styles, and enhancing cooperative work efforts in Native American elementary children in grades 3-6 (Smith, 1992). Ayersman (1996), in his review of hypermedia learning, also found that positive attitudes were evident. The last two benefits for hypermedia learning were identified as information synthesis and intertextuality.

Likewise, Palumbo and Prater (1993) revealed that information synthesis in hypermedia occurred as learners accessed a variety of tools (text, audio, video and graphics), in non-linear or linear formats, in order to constuct meaning. Thus, learners must synthesize a wide array of information in order to logically represent their thoughts. The intertextuality of hypermedia was defined by Yang (1995) as the juxtapositioning of multiple sign systems (text, images, graphics, etc.) which allow the learner to connect and generate relationships. Yang concluded that as learners engaged in intertextual investigations utilizing hypermedia, problem-solving opportunities would be supported.

In reviewing CAI and hypermedia learning it is evident that significant transformations have occurred in the use of integrating computer technology into the classroom. Early proponents of CAI viewed the computer as a replacement for the instructor, whereas hypermedia and multimedia computer platforms have altered this view to include Greenleaf's (1994) vision that computers should not function as independent variables in classrooms but as complex networks of social interactions. Therefore, it is necessary to review research on teacher writing curriculum implementation of computer technology in the classroom. However before examining the integration of hypermedia applications and writing curriculum it is first necessary to view pre-hypermedia integration of computers and writing into the classroom.

Writing Instruction And Computers

According to Costanzo (1994): "computers are altering the way many of us read, write, and even think. It is not simply that the tools of literacy have changed: the nature of texts, of language, of literacy itself is undergoing crucial transformations (p. 11). Constanzo also pointed out that simply writing with a keyboard to create text is vastly different from writing on paper. The advent of Desktop Publishing (DTP) facilitated the proliferation of word processor use, which Wahlstrom (1994) defined as: (a) computers capable of digital storage; (b) software that synthesizes the computer with typesetting equipment; (c) software consisting of versatile word processing; and (d) laser printers. Research on the effects of writing with DTP using word processors was extensively reviewed by Reed (1996).

Reed's Review[2]

In a meta-analysis of computer-based writing research (research on the use of word processors in writing instruction environments) on students, elementary aged through college, Reed determined that two distinct types of studies were conducted in two time periods: research before 1988 which tended to focus on isolated writing skills and research after 1988 grounded in theoretical frameworks. Three theoretical frameworks, emanating from process writing instruction, were identified: (a) writing process theory, (b) the zone of proximal development and (c) learner control theory.

Although writing process theory was examined earlier in this paper, however a brief overview of it will facilitate understanding of the two types of computer-based writing

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[2] This entire section is based on Reed (1996).

Although writing process theory was examined earlier in this paper, however a brief overview of it will facilitate understanding of the two types of computer-based writing research identified by Reed. Writing process theory derives from research dating back to 1965. Good writers, of that period, divided writing into three distinct categories: (a) pre-writing, (b) drafting, and (c) revision. The second framework Reed identified was the zone of proximal development which he defined as the zone between what students can achieve on their own and what they can achieve with assistance. For computer-based writing instruction (designed from the CAI-learning frameworks of computer as teacher replacement) the computer was thought to serve as a facilitator for enabling students to accomplish more in writing than they would without the computer.

Learner control theory was the third framework identified by Reed which stipulated that the more control a learner had over instructional decisions the better she learned. But, Reed found mixed results on learner control theory in his analysis-high-ability learners achieved more in computer-based writing studies when learner control was increased comparison to low-ability learners, who achieved less when learner control was increased.

Pre-1988 Computer-based Writing Research

Computer-based writing research before 1988 did not utilize process writing frameworks and learner control was low for these studies. The numerous studies (over 50) reviewed by Reed revealed that participants, in a ratio of 4 to 1, performed better when using the computer when tested in the following general areas: (a) reading skills, (b) language skills, (c) writing skills, and (d) revision. However, when the participants were elementary children, the studies tended to have low effect sizes, or less impressive results, as compared with studies utilizing older participants. Likewise, Reed found that studies using brief treatments (skills treatments) had lower effect sizes than studies involving longer treatments (writing process treatments). Thus, for pre-1988 studies Reed concluded that research grounded in processed-based writing instruction theory, produced positive results over studies that involved isolated skills.

Post-1988 Computer-based Writing Research

Reed reviewed two types of research: (a) participants experience with the use of unmodified word processing programs and (b) modified word processing programs, modified to include means for pre-writing, drafting and revision. For both categories of studies Reed found that participants internalized process writing strategies when provided a longer period of time to engage in process writing. The internalization of writing process strategies only served to improve writing as rationalized by Grimm (1995) and Kumpulainen (1994) when they determined that the computer alone cannot create powerful environments for learning writing. On the other hand, in shorter studies not requiring process writing curriculum, Reed concluded that participants did not internalize process writing skills.

The Bank Street Writer was a commonly used word processor for unmodified work processing studies in elementary computer-based writing curriculum. Bank Street Writer was identified by Evans (1983) and Stromberg (1983) as a proven and usable authoring system that enabled students to compose, substitute words, find definitions, and combine and extend sentences. For unmodified word processing, Reed found that elementary students who used word processors to write improved the quality of their writing and revision skills, and experienced enjoyment of the task, compared with students who wrote on paper. This study was measured in t-unit length which denotes the level of syntactic complexity. In a recent study measured by length of composition, Nichols (1996) also concluded that elementary children using unmodified word processors demonstrated improvement in writing while working on a word processor. Snyder (1994) found that children writing with computers using unmodified word processor programs had less fear and anxiety than children writing on paper.

Reed distinguished between studies utilizing unmodified word processors by pointing out two elements that modified word processors contained: (a) pre-writing prompts and (b) automatically appearing pre-writing prompts. For modified word

processing studies that utilized pre-writing prompts, Reed found that students rarely accessed the available prompts and therefore did not improve student writing as a result of the added prompts. However, for modified word processors with automatically appearing prompts, student writing improvement was facilitated.

While Reed's review also covered the effects of computer-based writing research within the realm of DTP, particularly word processing technology, new technological advances and developments in educational computer use, particularly those in the field of hypermedia and multimedia learning reviewed earlier in this paper dictate that a review of the integration of hypermedia and process writing be examined. (For a summary of Reed see Figure 3-Research on Computer-based Writing Instruction).

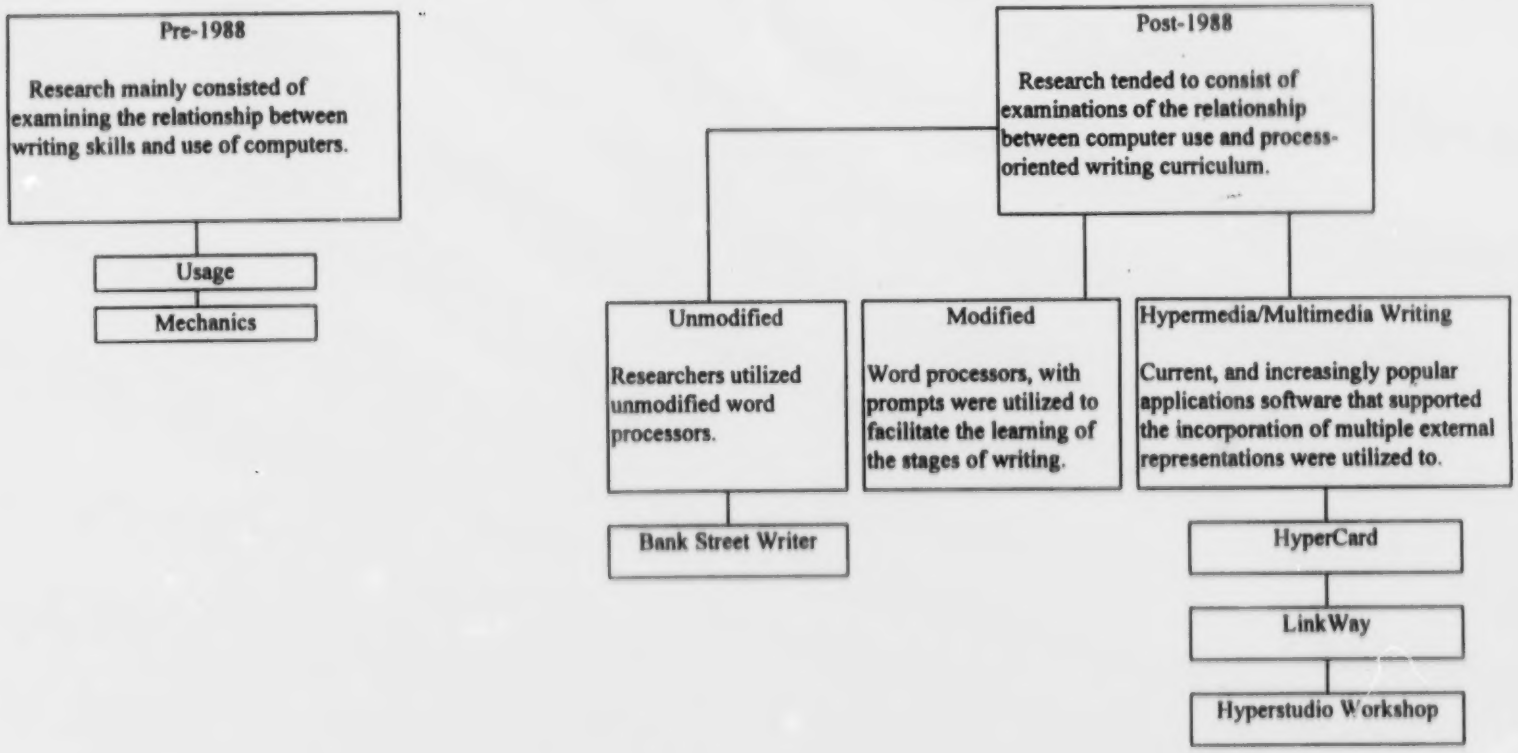
Hypermedia Writing

Rationale for Hypermedia Writing Instruction

Swan and Meskill (1996), in their critical evaluation of educational hypermedia software, found hypermedia to be a potentially suitable environment for literacy learning that included support for: (a) independent learning, (b) cooperative learning, (c) non-linear representations of knowledge, (d) a wide array of learning styles, and (e) enabling teachers to evaluate their own ideas of the role of text in the teaching of writing and reading.

According to Ayersman (1996), student-created hypermedia documents containing presentations with any combination of text, hypertext, graphics, audio and video which focused on disciplinary topics, can enhance learning since this environment supports constructivist theory. These hypermdedia attributes (text, hypertext, graphics, audio and video) were identified as features conducive to the teaching of writing. Hypermedia documents contain hypertext, which was defined by Palumbo and Prater (1993) as dynamic text that allows the writer to connect text to another hyperdocument which in turn could also be connected or linked to other hyperdocuments. Thus, hyptertext was thought to support learner-created non-linear formats as well as linear formats. Non-linear hypertext is text not sequenced in the usual straight line consisting of a beginning, middle

Figure 3 Research on Computer-based Writing Instruction


Pre-1988
Research mainly consisted of examining the relationship between writing skills and use of computers.
Usage
Mechanics
Post-1988
Research tended to consist of examinations of the relationship between computer use and process-oriented writing curriculum.
Unmodified
Researchers utilized unmodified word processors.
Bank Street Writer
Modified
Word processors, with prompts were utilized to facilitate the learning of the stages of writing.
Hypermedia/Multimedia Writing
Current, and increasingly popular applications software that supported the incorporation of multiple external representations were utilized to.
HyperCard
LinkWay
Hyperstudio Workshop

and end. It was considered to be advantageous because it mirrored the associative manner in which people think (Takyoshi, 1995).

Additional reasons for hypermedia enhancing and supporting writing instruction were conveyed by Yang (1996) who stated that hypermedia writing environments can support a variety of cognitive processes conducive to the learning of writing by facilitating the following processes: (a) organizing, (b) selecting, and (c) connecting. These three processes identified by Yang were thought to enhance, what Charney (1994) referred to as "idea manipulation" or discourse synthesis in writing (p. 239). Palumbo and Prater (1993) defined discourse synthesis as the hybrid act of reading and writing that occurs as information from a variety of sources are organized with hypertext.

Finally, the multimedia features inherent in hypermedia learning environments were identified by Daiute (1994) as conducive to the enhancement of young children's' writing. Daiute also found that student manipulation of sounds and images in the form of concrete cultural symbols may aid in the learning of text. She further rationalized that:

> since some of the functions of written language, like providing information and means of expression, can be served by other symbols systems, it is worth exploring children's use of a variety of symbol systems and relationships between visual systems, aural systems, and text (p. 221).

Research on Hypermedia and Multimedia Writing Instruction

Research conducted on hypermedia writing curriculum revealed that writing instruction was facilitated in the following ways: (a) student cultural learning styles needs were met, (b) narrative and episodic story structure was enhanced, and (c) motivation to write was increased.

Smith (1992) engaged Navajo elementary boarding school children (grades 3-6) in the implementation of the hypermedia authoring software Linkway which supported the integration of text, audio, video and graphics for I.B.M. compatible computers, similarly to HyperCard (Wagner, 1990) and Hyperstudio (Wagner, 1995) for Macintosh operating

environments. The children were led through the creation of stories and were encouraged to integrate familiar images in picture form into their documents. Results of the study indicated three benefits for hypermedia writing: (a) different cultural learning styles were met; (b) student lack of background experience was addressed in a meaningful way through the use of multimedia images; and (c) motivation was increased as evidenced by the children's fascination with the hypermedia writing environment.

Daiute and Morse (1994) conducted an in-depth case study on eight children (grades 3-4) identified as reluctant writers. The study utilized Personal Media Studio, a multimedia writing program. Results of extensive narrative data indicated that, for both high-ability and low-ability participants, the learning of written language can be enhanced by multimedia environments. Students were highly motivated, particularly when they integrated pictures and sounds into their stories.

McLellan (1992), in case study research of a hypermedia writing curriculum, investigated how elementary students (grade 5) would excel in narrative writing in the HyperCard (Wagner, 1990) environment. Students developed their own stories and manipulated the non-linear hypertextual features of the software. The level of details were strengthened in both narrative and episodic story structures, and McLellan noted that the children quickly adapted to the hypermedia environment.

Conclusion

The connection between the three educational fields of process writing, writing assessment and computer-based writing instruction for elementary-aged students was made evident by the parallel shifts that occurred in each field. Work in the field of process writing theory has clearly influenced transformations in writing assessment and computer-based writing instruction. As new methods of writing instruction were developed, so were new writing assessments and computer-based writing instructional strategies. As measures of writing assessment changed to instruments that evaluated products of process writing curriculum process writing curriculum was also supported. Likewise, as writing

assessments increasingly met the needs of process writing teachers, computer-based writing curriculum approaches began to make use of process writing methods. However, as newly popular environments of writing with computers have arrived, in the form of hypermedia writing new assessments must be developed to assist teachers in the guidance and evaluation of student performance.

Future Implications: A Call For Writing Assessment Research

The proliferation and increasing popularity among elementary school teachers of hypermedia learning environments, particularly for writing, dictate that research needs to address this new frontier. Several researchers have expressed the desire that new research for hypermedia writing be developed (Palumbo & Prater, 1993; Yang, 1995; Kinzer & Leu, 1997; and Reed, 1996). Palumbo and Prater (1993) and Ayersman (1996) further related that new assessment research is especially necessary in order to facilitate the development of writing instruction that makes effective use of hypermedia. Gearhart, Herman, Novak and Wolf (1995) concluded, that writing assessment research is needed to determine the factors that support or constrain the judgments of popular and extensively researched writing rubrics, particularly the Writing What Your Read analytic/holistic rubric and the 6-Point Analytic Writing Rubric. Thus, there is a particular need for writing assessment research to be conducted on the types of material to be rated, such as hypermedia documents instead of pen and paper-created documents.

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